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(54) **DEVICE AND VEHICLE OR PRODUCTION MACHINE**

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(58) **Field of Classification Search**

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USPC 60/607–608, 614, 624, 618, 486; 123/561

See application file for complete search history.

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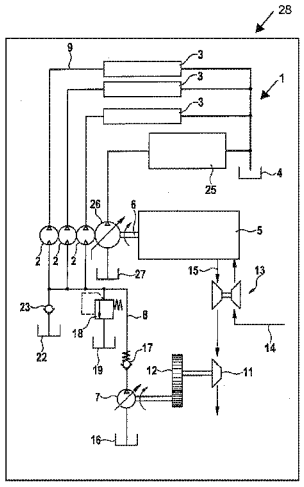
(57) **ABSTRACT**

A device for a vehicle or a production machine, having: a first hydraulic pump, which hydraulically drives a load; an internal combustion engine, which mechanically drives the first hydraulic pump; a second hydraulic pump, which is hydraulically coupled to the first hydraulic pump; an apparatus, which drives the second hydraulic pump while utilizing the energy in the exhaust gas stream of the internal combustion engine; the load on the output side being directly connected to a tank.

14 Claims, 3 Drawing Sheets



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F01N 5/04	(2006.01)
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F02B 41/10	(2006.01)

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Fig. 1

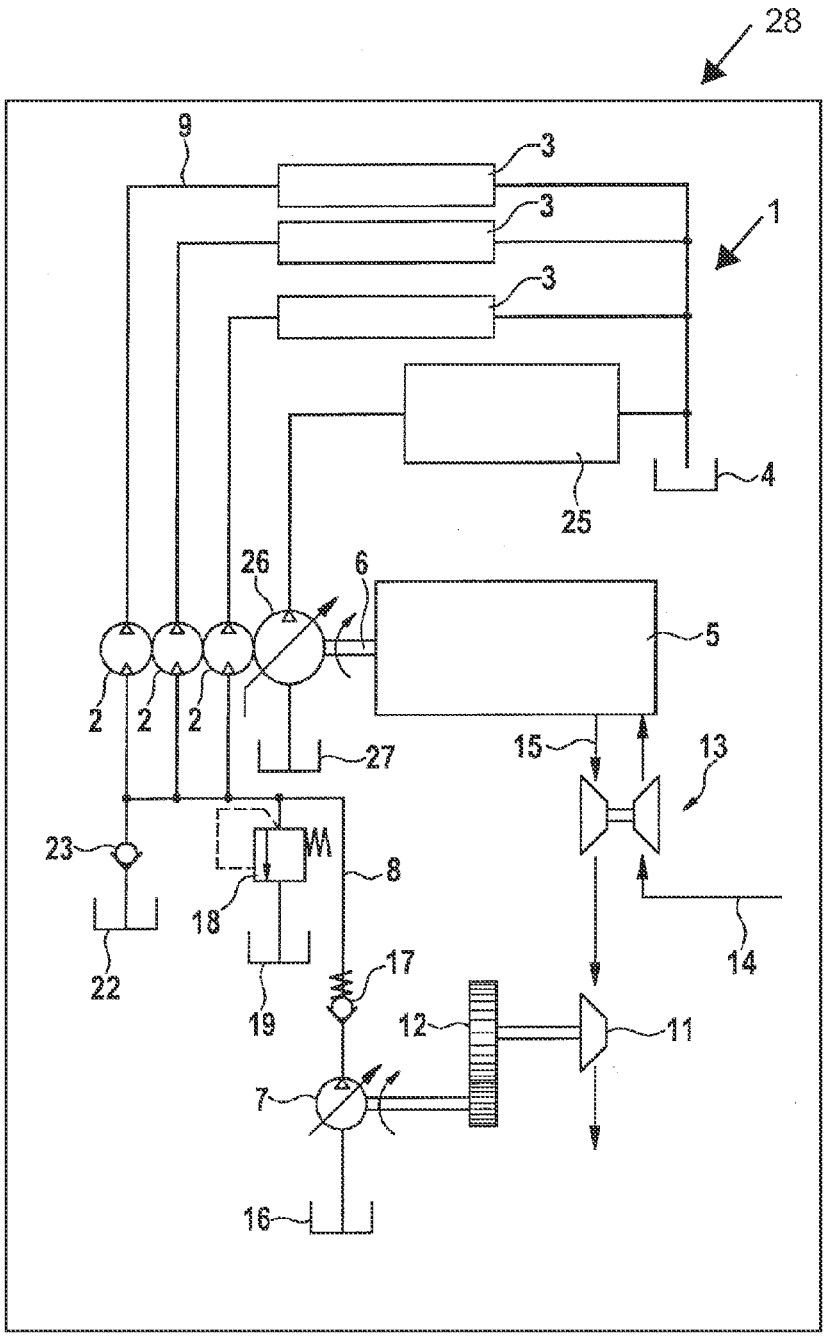


Fig. 2

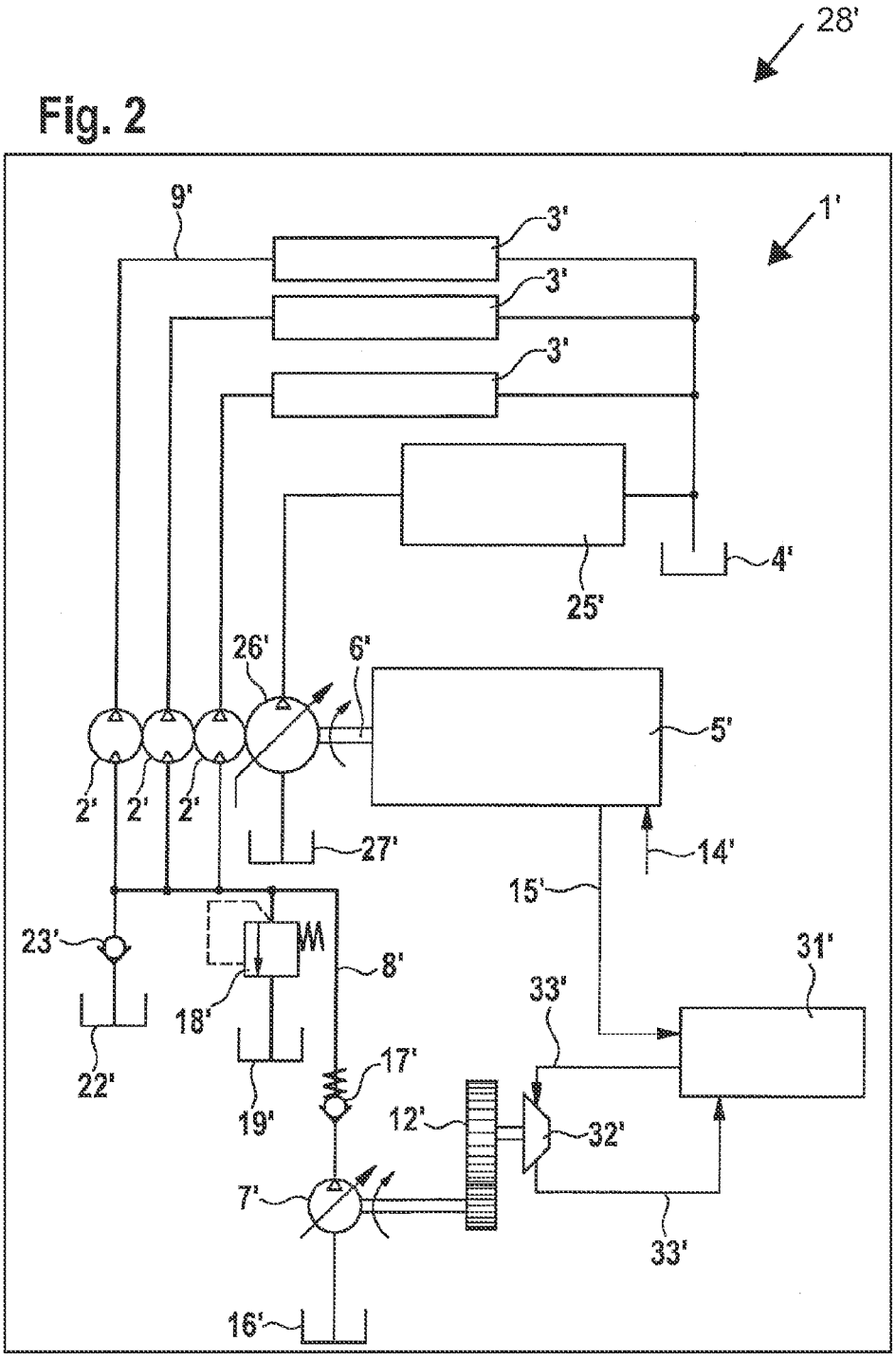
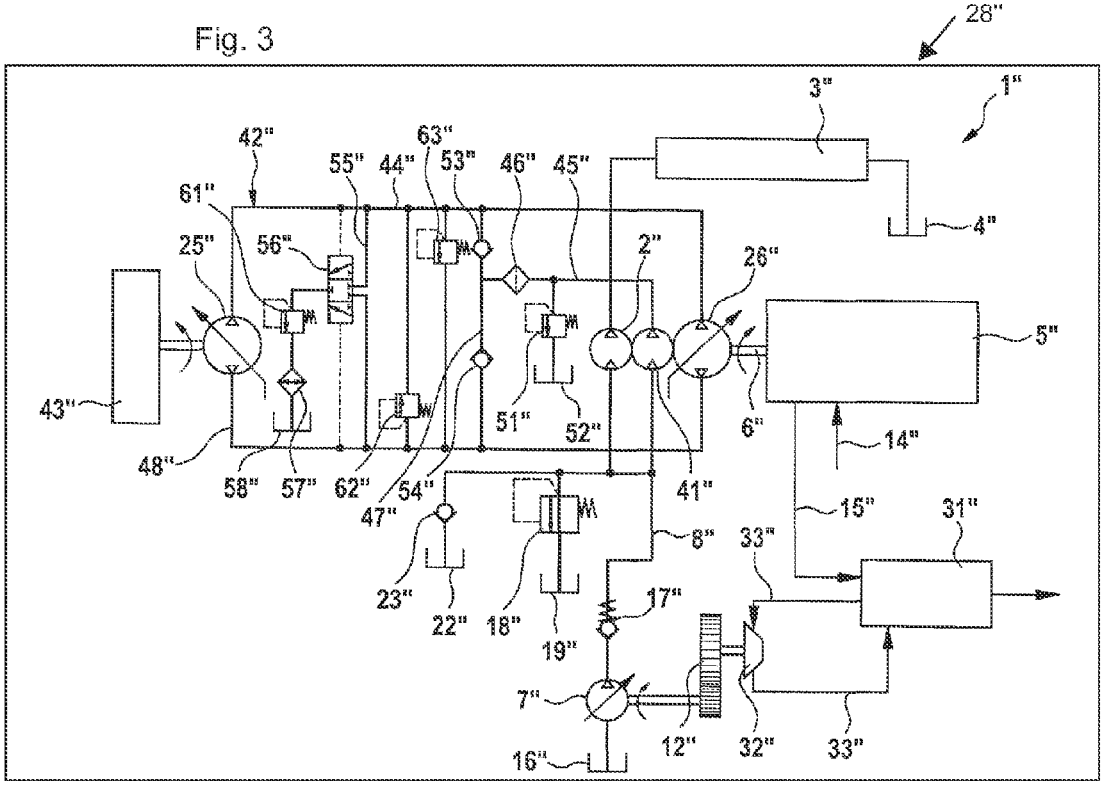


Fig. 3


28"
1"
3"
4"
5"
2"
26"
6"
14"
15"
31"
33"
8"
17"
7"
12"
32"
33"
16"
42"
63"
55"
44"
53"
46"
45"
61"
25"
56"
43"
48"
58"
57"
62"
54"
47"
51"
52"
41"
23"
22"
18"
19"

DEVICE AND VEHICLE OR PRODUCTION MACHINE

FIELD OF THE INVENTION

The present invention relates to a device for a vehicle or a production machine as well as a vehicle or production machine.

BACKGROUND INFORMATION

A device according to the definition of the species in Claim **1** is discussed, for example, in German document DE 42 12 984 C2.

The device of DE 42 12 984 C2 has a first hydraulic pump, which drives an hydrostatic motor hydraulically. The hydrostatic motor, in turn, drives several ancillary assemblies using a belt. Furthermore, the device has an internal combustion engine, which mechanically drives the first hydraulic pump using a power train. In addition, a second hydraulic pump is provided which is hydraulically coupled to the first hydraulic pump. The second hydraulic pump is driven by a turbocharger in the exhaust gas stream of the internal combustion engine.

SUMMARY OF THE INVENTION

The device according to the present invention specified herein and the vehicle according to the present invention specified herein or the production machine according to the present invention specified herein have the advantage over the usual design approaches that, because the load is on the output side directly connected to a tank, only a slight regulating effort arises for regulating the first hydraulic pump. For, bringing into line, between the first and second hydraulic pump, the required hydraulic fluid volumes conveyed by them respectively may be extensively omitted in the design approach according to the present invention. For example, the first hydraulic pump could even be provided with a constant absorption volume.

The statement that the "load is on the output side directly connected to a tank" means, in this case, that the first hydraulic pump is operated in an open circuit with the load.

The features indicated in the respective dependent claims relate to advantageous refinements and improvements of the subject matter of the present invention.

According to one refinement of the device of the present invention, a check valve is situated between the first and the second hydraulic pump. On the one hand, the second hydraulic pump oscillates based on the varying exhaust-gas stream of the internal combustion engine, which results in a corresponding oscillation of the hydraulic fluid conveyed by the second hydraulic pump. On the other hand, the first hydraulic pump oscillates based on rotational speed changes of the internal combustion engine which, in turn, results in an oscillation of the hydraulic fluid conveyed by the first hydraulic pump. Using the check valve, an oscillating decoupling is advantageously managed between the first and the second hydraulic pump.

Exemplary embodiments of the present invention are depicted in the drawings and explained in greater detail in the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows schematically a device according to an exemplary embodiment of the present invention.

FIG. **2** shows a variation of the device according to FIG. **1**.

FIG. **3** shows a device according to an additional exemplary embodiment of the present invention.

DETAILED DESCRIPTION

In the figures, like or functionally equivalent elements are denoted by like reference numerals, provided that nothing is indicated to the contrary.

FIG. **1** shows a device **1** according to an exemplary embodiment of the present invention.

Device **1** may be integrated, for instance, in a vehicle **28**, especially in a motor vehicle or a production machine, such as an excavating machine, a tractor or a harvester combine.

Device **1** has a plurality of hydraulic pumps **2**. First hydraulic pumps **2** may have a constant absorption volume. First hydraulic pumps **2** (also designated as auxiliary pumps) each hydraulically drive an auxiliary load **3** using hydraulic lines **9**.

The solid lines shown in FIGS. **1** through **3** indicate hydraulic lines. Only for example are two of the hydraulic lines designated by reference numerals **8** or **9**.

An auxiliary load **3** typically has an hydraulic motor (not shown) for mechanically driving various auxiliary assemblies, such as a generator, a cooling means pump, a compressed air compressor and/or an air conditioning compressor. The hydraulic motor that is not shown may also drive a blower for cooling engine cooling fluid and hydraulic oil, as well as one or more feed pumps for the actuation of valves of the working hydraulics. The components driven by the hydraulic motor are also not shown in FIG. **1**.

As may further be inferred from FIG. **1**, auxiliary loads **3** are each connected directly to tank **4** on the output side. This means that first hydraulic pumps **2** supply auxiliary loads **3** with hydraulic fluid in an open circuit.

In addition, device **1** has an internal combustion engine **5**. Internal combustion engine **5** includes a shaft **6** by which it particularly drives directly, mechanically first hydraulic pumps **2**.

Device **1** further has a second hydraulic pump **7**. Second hydraulic pump **7** may have an adjustable absorption volume. Furthermore, second hydraulic pump **7** may be a pressure-regulated or a power-regulated pump. The use of electrohydraulics for controlling second hydraulic pump **7** is not required, based on the low regulating effort required.

Second hydraulic pump **7** is driven by a turbocompound turbine **11** using a transmission **12**. In this context, turbocompound turbine **11** is postconnected to a turbocharger **13**, for example, which supplies intake air **14** to internal combustion engine **5**, and charges it thereby. Turbocharger **13** is driven itself, in turn, by exhaust gas stream **15** of internal combustion engine **5**. Exhaust gas stream **15** first flows through turbocharger **13**, and after that, through turbocompound turbine **11**.

Instead of the postconnected situation of turbocompound turbine **11**, the latter could also be used by itself, i.e. without turbocharger **13**. Furthermore, turbocompound turbine **11** could also be provided in parallel with turbocharger **13**, or preconnected to it.

Turbocompound turbine **11** at present thus develops an apparatus which drives second hydraulic pump **7** while utilizing the energy in exhaust gas stream **15** of internal combustion engine **5**. Consequently, second hydraulic pump **7** is able to be driven efficiently.

Using hydraulic line **8**, second hydraulic pump **7** pumps hydraulic fluid from a tank **16** through a check valve **17** to the suction side of first hydraulic pumps **2**. In order to guard against a possible overpressure in this instance, which could lead to damage of device **1**, a pressure limiting valve **18** is

provided including a tank **19** between check valve **17** and the suction side of first hydraulic pumps **2**.

First hydraulic pumps **2** are furthermore connected on the suction side with a tank **22** using a check valve **23**.

Device **1** also has a main load **25**. Main load **25** is particularly a production hydraulic system, particularly one or more hydraulic cylinders of the production machine or one or more hydraulic motors for driving the vehicle. For the sake of clarity, at present neither the hydraulic cylinder nor the hydraulic motor is shown in FIGS. **1** and **2**.

Moreover, device **1** has a third hydraulic pump **26** (which is also designated as main pump) which is driven mechanically using shaft **6** of internal combustion engine **5**.

Third hydraulic pump **26** may be configured having an adjustable absorption volume.

Third hydraulic pump **26** conveys hydraulic fluid from a tank **27** to main load **25** and drives it thereby. Main load **25** on its output side is directly connected to tank **4**.

Below, we shall briefly explain the functioning of device **1** in greater detail:

Second hydraulic pump **7** raises the pressure of the hydraulic fluid, which may be an hydraulic oil, for example, on the suction side of first hydraulic pumps **2**. Thereby the mechanical power supplied by internal combustion engine **5** using shaft **6** is reduced, which power is required to drive first hydraulic pumps **2**. As a result, internal combustion engine **5** is unloaded.

If suddenly more power is demanded of internal combustion engine **5**, by supplying it with more fuel, the energy rises noticeably in exhaust gas stream **15**, without this resulting immediately in an higher rotational speed of shaft **6** and thus in an higher pumping performance of first hydraulic pumps **2**. The higher energy in exhaust gas stream **15** leads to second hydraulic pump **7** taking up more power and thereby making available an higher hydraulic fluid volume on the suction side of first hydraulic pumps **2**. In the ideal case this may lead to the suction side pressure of first hydraulic pumps **2** corresponding to their pressure side pressure, the load pressure, so that first hydraulic pumps **2** take practically no power at all from internal combustion engine **5** using shaft **6**. Since, in this case, no leakage losses at all occur at first hydraulic pumps **2**, the efficiency of device **1** is particularly high in this case. The pressure on the suction side of first hydraulic pumps **2** may also become greater than the load pressure, first hydraulic pumps **2** then going over into motoric operation and unloading the internal combustion engine.

If the pressure at the suction side of first hydraulic pump **2**, i.e. in hydraulic line **8**, is too high, second hydraulic pump **7** may be swiveled back and/or a volume stream may be led off via pressure limiting valve **18** into tank **19**, so that the pressure drops in line **8**.

In the reverse case, namely, that internal combustion engine **5** suddenly demands less power, and therefore less fuel is supplied to it, the energy in exhaust gas stream **15** drops suddenly, while the power of internal combustion engine **5** that is output by shaft **6** to first hydraulic pumps **2** still essentially remains constant. This then leads to the situation in which, at the suction side of first hydraulic pumps **2**, hydraulic fluid volume provided using second hydraulic pump **7** is not sufficient to cover the hydraulic fluid volume aspirated by first hydraulic pumps **2**. In this case, check valve **23** opens, and first hydraulic pumps **2** are thus able to take up additional hydraulic fluid from tank **22**.

If second hydraulic pump **7** is designed as a swivel (FOOT) pump, that is, a pump having an adjustable absorption volume, the possibility comes about of a rotational speed regulation of turbocompound turbine **11**, so that the latter is able to be operated at the best point of its efficiency characteristics map. The turbine efficiency is a function of the ratio of the pressures before and after turbocompound turbine **11** as well as of the mass flow and the turbine rotational speed. Since turbocompound turbine **11** is aiming at power equilibrium, it is able to be speeded up by a reduction of the swivel angle of second hydraulic pump **7** and its thereby reduced absorption volume, because thereby the load moment drops off.

Check valve **17** advantageously takes care of the aforementioned oscillation technology decoupling between first hydraulic pumps **2** and second hydraulic pump **7**.

FIG. **2** shows a possible variant of device **1**, and is designated by **1'**, in a vehicle **28'**. In the following, we shall only go into the differences between device **1'** and device **1**.

Instead of turbocharger **13** and turbocompound turbine **11** according to FIG. **1**, device **1'** has an heat exchanger **31'** and a steam turbine **32'**. In heat exchanger **31'**, steam **33'** is generated for driving steam turbine **32'**, using the energy obtained in exhaust gas stream **15'**. Steam turbine **32'**, in turn, drives second hydraulic pump **7'** using gearing **12'**.

FIG. **3** shows schematically a device **1"** according to an additional exemplary embodiment of the present invention.

It is envisaged that one might typically use device **1"** in the case of a mobile production machine, for instance, a tractor **28'"**.

Device **1"** differs from device **1'** of FIG. **2** as follows:

Device **1"** has only one first hydraulic pump **2"**. However, a plurality of first hydraulic pumps **2"** could also be provided, of course.

In addition to first hydraulic pump **2"**, a fourth hydraulic pump **41"** is provided. Fourth hydraulic pump **41"** is connected on the suction side to second hydraulic pump **7"** using hydraulic line **8"** and check valve **17"**. Fourth hydraulic pump **41"** is a feed pump, which supplies a closed hydraulic circuit **42"** with hydraulic fluid.

In closed hydraulic circuit **42"**, hydraulic fluid is pumped using third hydraulic pump **26"** through a main load **25"** developed as an hydraulic motor.

Main load **25"** drives a wheel **43"** of the tractor. For this, closed hydraulic circuit **42"** has hydraulic lines **44"** and **48"** connecting third hydraulic pump **26"** to main load **25"**.

Fourth hydraulic pump **41"** is connected on the suction side to an hydraulic line **47"** using hydraulic line **45"** and a filter **46"**.

A pressure relief valve **51"** connected to hydraulic line **45"** limits the pressure in hydraulic line **45"**. When there is an overpressure in hydraulic line **45"**, hydraulic fluid is withdrawn into a tank **52"** using pressure limiting valve **51"**.

Hydraulic line **47"** is connected at each end, using a check valve **53"** and **54"**, respectively, to hydraulic line **45"** and **48"** of hydraulic circuit **42"**.

Depending on the direction of rotation of main load **25"**, hydraulic line **44"** represents a supply or draining line for the hydraulic fluid. If, for example, hydraulic line **44"** is functioning as a supply line, hydraulic line **48"** forms a corresponding draining line, and vice versa.

In the operation of main load **25"**, at its draining side, formed by hydraulic line **44"**, a part of the hydraulic fluid is drained using hydraulic line **55"** and an hydraulic circuit **56"**, through a cooler **57"** into a tank **58"**. Between cooler **57"** and hydraulic circuit **56"**, an additional pressure limiting valve **61"** may be situated.

The drained hydraulic fluid is replaced by the hydraulic fluid followed up by fourth hydraulic pump **41"**. For this, hydraulic fluid flows, in the present case, from hydraulic line **47"** through check valve **53"** into draining line **44"**.

Consequently, filtration and cooling of the hydraulic fluid flowing in hydraulic circuit **42"** may be ensured. Also, leakage losses, that are created in hydraulic pump **26"** and hydraulic motor **25"**, are compensated for using hydraulic pump **41"**.

Furthermore, a pressure limiting valve **62"** may be provided, which, in the case of an overpressure, enables the flowing of hydraulic fluid from hydraulic line **48"** to hydraulic line **44"**. Furthermore, a pressure limiting valve **63"** may be provided, which, in the case of an overpressure, enables the flowing of hydraulic fluid from hydraulic line **44"** to hydraulic line **48"**.

Instead of heat exchanger **31"** and steam turbine **32"**, in device **1"** according to FIG. **3**, turbo-charger **13** could also be used with turbocompound turbine **11** of FIG. **1**.

Although the present invention was described above specifically with reference to an exemplary embodiment, it is not limited to that, but may be modified in many ways. In particular, the refinements and the exemplary embodiments described for the device according to the present invention are applicable to the vehicle according to the present invention and to the production machine according to the present invention in a corresponding manner. Moreover, it should be mentioned that "ein" (=one or a or an) in the present text does not exclude a plurality.

In the case of the abovementioned hydraulic pumps having constant absorption volume, gear pumps may be involved. Variable displacement pumps may be swash plate pumps or bent axis pumps. The same applies for the abovementioned hydraulic motors.

First hydraulic pumps **2** are also able to be operated as hydraulic motors. This applies particularly in case the hydraulic pressure provided using second hydraulic pump **7** exceeds the hydraulic pressure on the pressure side of first hydraulic pumps **2**.

What is claimed is:

1. A device for a vehicle or a production machine, comprising:

a first hydraulic pump, which hydraulically drives a load, and which is mechanically driven by an internal combustion engine;

a second hydraulic pump, which is hydraulically coupled to the first hydraulic pump;

an apparatus, which drives the second hydraulic pump, while utilizing the energy in the exhaust-gas stream of the internal combustion engine;

wherein the load is connected on an output side directly to a tank.

2. The device of claim **1**, wherein a check valve is situated between the first hydraulic pump and the second hydraulic pump.

3. The device of claim **1**, wherein the load is an auxiliary load and has an hydraulic motor for the mechanical driving of a battery of at least one of a generator, a cooling pump, an air pressure compressor and an air conditioning compressor.

4. The device of claim **1**, further comprising:

a main load and a third hydraulic pump, which hydraulically drives the main load;

wherein the internal combustion engine mechanically drives the third hydraulic pump.

5. The device of claim **4**, wherein the main load has a working hydraulic system, including at least one of a hydraulic cylinder of the production machine and a hydraulic motor for driving the vehicle.

6. The device of claim **4**, wherein the second hydraulic pump is further coupled to a fourth hydraulic pump, which feeds the hydraulic circuit forming the third hydraulic pump with the main load.

7. The device of claim **1**, wherein the apparatus has a turbocompound turbine, which is mechanically coupled to the second hydraulic pump for driving the second hydraulic pump.

8. The device of claim **7**, wherein:

the apparatus includes a turbocharger that is driven by the energy in the exhaust-gas stream of the internal combustion engine, and

the turbocompound turbine is driven by the turbocharger.

9. The device of claim **1**, wherein the apparatus has a steam turbine, which is mechanically coupled to the second hydraulic pump for driving the second hydraulic pump.

10. The device of claim **9**, wherein the turbocharger is one of: (i) in parallel to the turbocompound, and (ii) preconnected to the turbocompound.

11. The device of claim **1**, wherein, when a hydraulic pressure provided using the second hydraulic pump exceeds a hydraulic pressure on a suction side of the first hydraulic pump, at least one of the first, the third and the fourth hydraulic pump is also able to be operated as a hydraulic motor.

12. A vehicle or production machine, comprising:

a device for a vehicle or a production machine, including:

a first hydraulic pump, which hydraulically drives a load, and which is mechanically driven by an internal combustion engine;

a second hydraulic pump, which is hydraulically coupled to the first hydraulic pump;

an apparatus, which drives the second hydraulic pump, while utilizing the energy in the exhaust-gas stream of the internal combustion engine;

wherein the load is connected on an output side directly to a tank.

13. The vehicle of claim **12**, wherein the device further includes:

a main load and a third hydraulic pump, which hydraulically drives the main load;

wherein the internal combustion engine mechanically drives the third hydraulic pump.

14. A device for a vehicle or a production machine, comprising:

a first hydraulic pump, which hydraulically drives a load, and which is mechanically driven by an internal combustion engine;

a second hydraulic pump, which is hydraulically coupled to the first hydraulic pump;

an apparatus, which drives the second hydraulic pump, while utilizing the energy in the exhaust-gas stream of the internal combustion engine;

wherein the load: (i) is connected on an output side directly to a tank and (ii) is an auxiliary load and has a hydraulic motor for the mechanical driving of a battery of at least one of a generator, a cooling pump, an air pressure compressor and an air conditioning compressor.

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